Evaluation of Harpin for the Control of Insect-Vectored Bacterial Wilt of Pumpkin and Comparison of Cucurbit Crop Types and Cultivars for their Attractiveness to Cucumber Beetles and Susceptibility to Bacterial Wilt

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ABSTRACT

Recently there has been a dramatic increase in the occurrence of bacterial wilt, especially in pumpkin and squash, not only in New York, but also elsewhere in the U.S. The bacterium causing this disease (*Erwinia tracheiphila*) cannot be controlled directly with pesticides, therefore, management practices have targeted the insects that harbor and vector the pathogen, which are the striped and spotted cucumber beetles. Application of insecticides is the main management practice being used. The goals of this project, which was started in 1999, were 1) to determine if harpin can reduce beetle infestations and/or the occurrence of wilt and 2) to compare cucurbit crop types and cultivars for their attractiveness to cucumber beetles and susceptibility to wilt. Unfortunately, harpin does not appear to an effective tool for managing beetles or wilt in a highly wilt-susceptible pumpkin cultivar. It may be effective with other cucurbit crops.

This study provides growers with useful information about differences among cucurbit crop types and cultivars in attractiveness to cucumber beetles and susceptibility to bacterial wilt. It can be implemented now. With this information, growers can adjust their management program for cucumber beetles and wilt, thereby increasing their profitability and reducing insecticide use with some cultivars. For example, the pickling cucumber Country Fair was considerably less susceptible than the pickling cucumber Calypso and the slicer Dasher II, even under the high insect and disease pressure that occurred in this experiment. It could be grown without applying insecticides for cucumber beetles. On the other hand, the gourd Turk's Turban was very attractive to beetles and highly susceptible to wilt. Growers have complained that plants of this cultivar tend to die prematurely; results from this work reveal why. A more intensive insecticide program needs to be used with this cultivar where wilt occurs. Two pumpkin cultivars with resistance to powdery mildew (PMR) were more susceptible to wilt than other pumpkin cultivars. Fortunately there does not appear to be a general correlation between wilt susceptibility and PMR as the PMR muskmelon and yellow summer squash cultivars examined in this study were not more susceptible to wilt than the other cultivars examined. Waltham Butternut was less susceptible to wilt than other winter squash cultivars examined. Watermelon was less susceptible than other cucurbit crops. There will be no cost to implement the findings of this project unless the seed of a less

susceptible cultivar is more expensive than others or a more susceptible cultivar is selected for its horticultural characteristics necessitating that a more intensive insecticide program be used.

BACKGROUND AND JUSTIFICATION

Recently there has been a dramatic increase in the occurrence of bacterial wilt, especially in pumpkin and squash, and a new disease has appeared that is caused by the same bacterium (*Erwinia tracheiphila*). Cucurbit crops are very important for New York vegetable growers. The main management practice being used for wilt is application of insecticides to control the striped and spotted cucumber beetles which harbor and vector the pathogen. Cucumber beetles can cause extensive damage by feeding on leaves and rinds of cucurbits, but bacterial wilt has a much greater impact.

Substantial differences were detected among cucurbit crop types and among cultivars in attractiveness to beetles and susceptible to wilt through research conducted in 1999. The gourd Turk's Turban was very attractive to beetles and susceptible to wilt in the Suffolk County experiment. Turk's Turban also had more feeding injury than the gourd Pear Bicolored in the Tompkins County experiment. In contrast, watermelon and the winter squash Waltham Butternut did not develop bacterial wilt. Generally crops and cultivars with the highest density of cucumber beetles and the most feeding damage had the highest incidence of bacterial wilt: the gourd Turk's Turban, the winter squashes Golden Delicious and Blue Hubbard, the yellow summer squash Goldbar and the muskmelon Athena. However, while the pumpkins Harvest Moon and Howden had higher beetle infestations than Merlin, they had lower incidence of BW. PMR Merlin was demonstrated to be more susceptible to wilt than other pumpkin cultivars: 89% of Merlin plants but only 3% of Harvest Moon plants developed severe wilt by 25 Aug. Fortunately the PMR muskmelon and yellow summer squash cultivars evaluated were not more susceptible than other cultivars without resistance. A threshold of 1 beetle/plant for insecticide treatment appears to be inadequate for managing bacterial wilt in susceptible crops such as cucumber and susceptible cultivars such as Merlin considering the high incidence of wilt that occurred although this threshold was not reached in either cucumber cultivar examined or in Merlin. While there were similarities in rankings of crops and cultivars in amount of feeding damage at the two different locations, there were some differences which indicate the need for additional research.

Messenger could be a valuable tool for managing cucumber beetles and wilt. Harpin, the active ingredient in Messenger, is a protein originating from *Erwinia amylovora*. It has been shown to induce the natural defense system of plants (known as Systemic Acquired Resistance or SAR) for several diseases and to reduce insect attractiveness of treated plants. Messenger would be a safer alternative to chemicals that may be restricted or eliminated for cucumber beetle control as a result of The Food Quality Protection Act.

Pumpkins receiving both seed and foliar Messenger treatments had significantly less feeding damage and wilt than nontreated in the experiment conducted in Suffolk County in 1999. The difference in damage, however, was small (4.6% vs 5.8%). Incidence of bacterial wilt was significantly lower for plants treated with Messenger than nontreated on 2 of the 4 assessment dates. Incidence was 26-28% for Messenger-treated plants and 48% for nontreated on 21 July. However, disease pressure was very high in this experiment and almost all plants developed wilt by 17 Aug. Three applications may not have been enough.

OBJECTIVES

1. Determine if Messenger can reduce beetle infestations and/or the occurrence of bacterial wilt. (Experiment 1)
2. Compare cucurbit crops and cultivars for their attractiveness to cucumber beetles and susceptibility to bacterial wilt. (Experiment 2)
3. Assess whether powdery mildew resistant (PMR) cultivars are differentially more attractive to cucumber beetles or more susceptible to bacterial wilt than other cultivars. (Experiment 2)

Experiment 1. MATERIALS AND METHODS

The cultivar 'Merlin' was selected for this experiment because it was determined to be more susceptible to bacterial wilt than other pumpkins in 1999. Treatments included 1) Messenger applied as a foliar spray and 2) Messenger applied as a seed soak just before planting plus the 5 foliar applications. Treatment solutions were prepared by first mixing the surfactant Reguard plus the anti-chlorine compound STS with water (0.27 fl oz/gal) then adding Messenger. Seed were rinsed in water to remove fungicide, then about 120 seed were soaked in 2 qt of a 30 ppm Messenger solution while 240 seed were soaked in water with Reguard. Seed were soaked without agitation overnight for 16 hrs just before planting. Seed were planted by hand on 1 June. Rows were covered with remay cloth until plants germinated to prevent birds from eating seeds, as occurred in 1999. Plots were single rows of 10 plants spaced 24 in. apart. Plots were spaced 10 ft apart within a row and rows (replications) were spaced 17 ft apart. Messenger was applied as a foliar spray on 17, 23, and 30 June; and 8 and 17 July using a CO_2-pressurized backpack sprayer and hand-held boom equipped with a TeeJet TJ-60 11003 nozzle that delivered 50 gpa at 50 psi. The first foliar application could not be made at the cotyledon stage as planned because of rain or windy conditions; it was applied at the first leaf stage (17 June).

Plants were examined weekly for cucumber beetles, feeding damage, and symptoms of bacterial wilt. Wilt severity of each plant was assessed weekly from 30 June through 22 Aug as percentage of plant wilted. Wilt incidence in each plot was calculated for plants with any wilt symptoms, >10% wilted, >50%, >75%, and >90%. A total of 17 severely wilted plants, 3 to 4 from each replication, were selected on 7, 19 and 23 July. The basal portion of their main stem was removed and thin sections of stem were examined with a microscope for bacteria to confirm that they were succumbing to bacterial wilt.

Experiment 1. RESULTS AND DISCUSSION

Cucumber beetles were numerous and bacterial wilt was severe. Striped cucumber beetles were almost the only vector observed during this experiment. Very few spotted cucumber beetles were seen. Beetles and feeding injury were first observed on 17 June, which was 16 days after planting; none were seen 2 days earlier. Extensive feeding damage was observed on 23 June when plants were at the 2- to 3- leaf stage. Early symptoms of bacterial wilt, wilted sections of leaves, were first seen on 30 June, which was 29 days after planting. A few completely wilted plants were seen 1 week later. Bacteria were observed in all stems examined. No significant differences were detected among treatments in number of beetles/plant, percentage of cotyledons or whole plant with damage from cucumber beetle feeding, or incidence of wilt (Table 1). All plants wilted and died before Sept. There were a total of only 3, 6, and 1 good orange fruit on 23 Aug in all the nontreated plots, Messenger seed plus foliar treatment plots, and the

Messenger foliar treatment plots, respectively. In a similar experiment conducted in 1999, incidence of bacterial wilt was slightly lower for plants treated with Messenger.

Experiment 2. MATERIALS AND METHODS

At least one cultivar of each of the major cucurbit crop types were selected for this experiment (Table 2). These are the same cultivars used in 1999. An additional cultivar was included in the 2000 experiment: the cucumber Country Fair which is reported to be wilt resistant.

Seedlings at the cotyledon to one-leaf stage were transplanted into black plastic mulch on 9 June. Transplanting was done when plants were very young so that they would be in the field almost their entire life including the cotyledon stage when cucurbit crops are highly attractive to cucumber beetles. A nested statistical design was used with cultivar nested in crop and five replications. Plots were single rows of 8 plants at 24-in. spacing with 54 in. between plots in a row. Each row contained a replication. Rows were spaced 17 ft apart. Plants were watered using drip irrigation as needed based on irrometer readings. Weeds between rows were controlled by mechanically cultivating and hand-weeding. No insecticides were applied. Powdery mildew was managed by applying Quadris F (13.5 oz/A) on 5 and 18 Aug and Nova 40W (5 oz/A) + Bravo Ultrex (2.7 lb/A) on 11 Aug

Plants were examined weekly for cucumber beetles, feeding damage, and symptoms of bacterial wilt. Plants were considered severely wilted when they were at least 50% wilted. Feeding damage was assessed on cotyledons on 20 and 27 June, on all leaves on 3 July, and on lower stems on 11 July. A total of 99 severely wilted plants were selected on 12, 19 and 23 July; 9 and 30 Aug. The basal portion of their main stem was removed and thin sections of stem were examined with a microscope for bacteria in xylem to confirm that they were succumbing to bacterial wilt.

Experiment 2. RESULTS AND DISCUSSION

Compared to pest and disease pressure in a similar experiment in 1999, cucumber beetles were more numerous and bacterial wilt was more severe in 2000. Striped cucumber beetles were almost the only vector observed during this experiment. Very few spotted cucumber beetles were seen. Beetles and damage from their feeding were first observed on 20 June. No beetles were found on 14 June. An action threshold for foliar insecticide treatment of 1 beetle/plant is sometimes recommended for cucurbits. This threshold was exceeded on almost all cultivars on almost all assessment dates (22 June – 11 July) (Table 2). Symptoms of bacterial wilt were first observed on 3 July. The gourd Turk's Turban (*Cucurbita maxima)* was very attractive to beetles and highly susceptible to wilt, differing substantially from Pear Bicolored (*C. pepo*). All Turk's Turban plants were severely wilted by 8 Aug whereas no Pear Bicolored plants were severely wilted until mid-Aug and only 23% wilted by 22 Aug. This documents an important difference between these species that may extend to other gourds. The pickling cucumber Country Fair, which is reported to be wilt resistant, was substantially less susceptible to wilt than the other two cultivars examined (7% wilted versus all Dasher II and Calypso plants wilted by 22 Aug). This was not due to differences in beetle attractiveness as there were no significant differences among cucumber cultivars in number of beetles/plant or amount of feeding damage. Similarly, differences in susceptibility to wilt among pumpkin cultivars were not related to beetle density or feeding damage. A higher percentage of Merlin and Magic Lantern plants became severely wilted by 22 Aug than Harvest Moon and Howden plants (97-98% versus 53-58%). The more susceptible cultivars have powdery mildew resistance (PMR). Fortunately, there does not appear to

be a general correlation between wilt susceptibility and PMR as the PMR muskmelon and yellow summer squash cultivars examined (Eclipse, Athena, and Sunray) were not more susceptible to wilt than the other cultivars examined. Waltham Butternut (*C. moschata*) had fewer beetles and less feeding damage than other winter squash cultivars, and it was the last to develop wilt symptoms, which were not seen until 15 Aug. Watermelon was less attractive to beetles and less susceptible to wilt than other cucurbit crops.

CONCLUSIONS

Messenger does not appear to an effective tool for managing cucumber beetles or bacterial wilt in pumpkin. This product may be effective with other cucurbit crops and perhaps other pumpkin cultivars as SAR inducers have shown some variation in activity associated with the plant.

This study provides growers with useful information about differences among cucurbit crop types and cultivars in attractiveness to cucumber beetles and susceptibility to bacterial wilt. It can be implemented now. With this information, growers can adjust their management program for cucumber beetles and wilt, thereby increasing their profitability and reducing insecticide use with some cultivars. For example, the pickling cucumber Country Fair was considerably less susceptible than Dasher II and Calypso, even under the high insect and disease pressure that occurred in this experiment. It could be grown without applying insecticides for cucumber beetles. On the other hand, the gourd Turk's Turban was very attractive to beetles and highly susceptible to wilt. Growers have complained that plants of this cultivar tend to die prematurely; results from this work reveal why. A more intensive insecticide program needs to be used with this cultivar where wilt occurs. There will be no cost to implement the findings of this project unless the seed of a less susceptible cultivar is more expensive than others or a more susceptible cultivar is selected for its horticultural characteristics necessitating that a more intensive insecticide program be used.